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ABSTRACT

Training programs for data processing personnel are plagued by the rapid turnover of the technology involved. An attempt was made to provide a self-paced training plan for a large, data processing staff. Factor analyses of questionnaires about the skills and tasks involved divided the population into specialization groups. Within the specialization groups, judgements about levels of ability and levels of responsibility enabled construction of a statistical model which could be used for forecasting. (RH)

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Computer Based Instructional Design: Identifying Requirements
J. H. Bryant

Introduction

The title and abstract for this symposium connote the idea that its focus is simply the use of data processing in the instructional process. In a broad sense, this was the intent of the participants. However, it might not be entirely clear just what this step encompasses, or, at any rate should encompass.

Most paradigms for the process begin with "task analysis" or its equivalent, a step somewhat comparable to "system analysis" in the system development process. What this typically involves is the observation and documentation, in some fashion, of work currently being performed by, presumably, competent persons. Such information provides the criterion for inclusion and exclusion of terminal behavioral objectives.

The choice of currently performed work as a criterion is based on the assumption that what is being done will continue to be done in the future. Acceptance of this assumption generates several methodolcgical considerations - for example, what is a sufficient work sample - not always easy to resolve. It also ignores the significant question about the validity of current work as a criterion. This question becomes most obvious when considering training for work where technological changes are significant and frequent - for example, in the field of data processing. It is characterized by cycles of both major and minor change. Some cycles are short - 5 to 6 months when dealing with programs or programmed systems. With major components, such as computing equipment, the cycles are still not so long - say 2 to 3 years.

Under these conditions the consequences are predictable: the training development cycle required by the system approach is judged to be too cumbersome, costly and insensitive. Consequently, it and alternatives to conventional training are rejected or tried only if there is enough time and money to experiment.

While the preceding may be oversimplified, it is not unrepresentative of much of the technical training environment in business and industry. The use of current work as a criterion is partially responsible for the consequence along with the methodology and cost associated with the system approach. What is needed is a way to overcome the limitation of using the "present" as the only criterion for determining content and techniques which take less time and have better assurance of responsiveness, or a combination of these.

This paper focuses on the first of these topics. The other speakers will concentrate on other techniques. In order to address the question which has been raised, it is necessary first to interpret the training process within the context of the "work-production" system of which it is a part. It is necessary to encompass and incorporate long-range plans in the "requirements analysis" phase. Finally, it is necessary to establish routine mechanisms for feeding back the results of this analysis and its consequent processes into planning, into operations, and visa versa. This was attempted in an effort to plan a training program for professional data processing personnel in a large business concern. The effort involved considerable use of data processing, and hence has a bearing on the topic for this session. How and for what data processing was (or was planned to be) used will be pointed out as the process is described.

Training Environment

The training program was for a professional data processing staff of over 1,000 members. Because of hiring and work patterns individualized, self paced technical training was considered desirable "wherever possible". The choice of method was to be based on the material and cost effectiveness considerations. The plan was to encompass the development of only those skills needed to do the work required to meet company objectives (as contrasted with general professional development, etc.).

In this environment, the work to be done was defined by current and long-range plans which included committments to develop new programmed systems, phase out old ones; use different software; revise operating techniques and responsibilities; etc. It was anticipated that there would be almost complete technological turnover in a period of 5 - 6 years. Generally, the work was planned on the basis of systems and projects, tasks and assignments. However, assignments were generally undefined beyond a 6 - 12 months period. Skill requirements were vague or not established. Position descriptions were general and non-distinct. In addition to whatever technical skills might be required, organizational policies and traditions imposed other 'managerial' and 'administrative' skill requirements. The entire organization of personnel operated within a framework of company and "professional" policies and procedures, which formed and contributed to the characteristics (in a statistical sense) of the organization.

Technical training was only one of the tools used by management to get the necessary skills to do the required work. It tended to be a less valued tool (because of sensitivity) than "recruiting" and "managing", but, nevertheless, constituted a significant tool. About 3% of the data processing budget directly and indirectly, was spent for it.

Preliminary Analysis

Figure 1 illustrates the sequence of steps taken in the "analysis" phase of the training development process. It also illustrates the relationships between it and the remainder of training development and other processes related to the training plan and program, the training process could not be separated from the others. Likewise, it was necessary to view the process as representing continuous functions interfacing and interacting with planning, selecting, placing, etc. rather than as a stable operation established on the basis of a snapshot taken at a point in time. Consequently, an attempt was made to convert or integrate analytical results into routine operating mechanisms wherever possible.

The first step of the development was aimed at providing a time phased definition of the training population and of the criteria for training. It consisted of analyses of:

- Technical Plans and Trends
- Current Operating Procedures and Characteristics (both work and organization related)
- Positions, assignments, tasks, skills in currently performed work.

The latter analysis was done in two cycles. The first was intended to obtain sufficient information to construct survey instruments that could be used to serve the analytical needs of this process as well as the others described below. The second cycle consisted of surveying the entire population. This substep was the first place where data processing was used - to create an analysis data base to be used at this stage and as a foundation for related operational components such as the personnel and skills information bank.

Task and Skill Analysis

The next major step was heavily computer dependant because of the method selected for the analysis. The objective was to reduce the task related survey data to the smallest set meaningful for personnel and training plans and operations. The method consisted or correlating and factor analyzing estimates of time spent in a list of data processing activities. This produced a structure of the work domain which was sufficient for separating the population into specialization groups and for indicating the relative significance of specific "activity clusters" to performance in that area of specialization. Figure 2 illustrates some of the results from this analysis. It shows activity profiles for two groups - application programmers, and data processing managers - in percent of time spent in the 8 task clusters resulting from the analysis.

Estimates of level of proficiency in lists of data processing behaviors (called skills) were also correlated and factored to structure the skills related to the activities of data processing work. This allowed comparison of the population by area of specialization in terms of skill clusters and also allowed the patterns of skill acquisition to be studied over time within areas of specialization. Figure 3 illustrates some of the results from this analysis. It shows the percent of the programming and managing groups who were considered to have acceptable proficiency in the skills represented by the "skill clusters". It is noted that some of the skill clusters related to specific computer systems which were scheduled for change. This type of information tended to simplify subsequent decisions about the training program.

In addition to separation of the population into specialization groups, it was considered desirable to separate each group into sub-groups by "level of ability" (positions). This was desirable for program planning but was required for other personnel processes such as classification and compensation. It also facilitated personnel selection. To accomplish this, ratings were collected from technical personnel and technical managers on the level of difficulty of tasks in the task lists and level of complexity of items in the skill lists. The same judges also estimated the relative importance of each task and skill cluster to performance in each area of specialization. Judgments about "level of responsibility" factors were also made. An algorithm was defined which combined all of the information into a set of indices which could be used to accomplish the sub-group separation and allow comparisons across groups. Figure 4 illustrates the results by showing the distributions of programmers and managers on an overall index. This information was used to divide the groups into normative and extreme groups. Analysis of task and skill characteristics were made within each specialization and proficiency level.

The final algorithms were specified for inclusion in the operational personnel system as the basis for employee classification. Also, it was considered necessary to repeat the entire set of analyses periodically as changes occured in plans, assignments, etc. The personnel and skills data bank and supporting procedures were specified so as to accommodate the information needed for these analyses, as well as changes that would occur over time. Files and programs used in these analyses were sufficiently generalized to accommodate these changes and were recommended as the foundation for the corresponding operational data bank.

Forecasting

The last analysis in this set culminated all the preceding. It consisted of interpreting position and task analysis information as well as planning and trend information so as to extend the lists of positions, assignments, and/or tasks. These were then combined with the current and historical characteristics of the organization to formulate a statistical model of the "work/performance" domain which would simulate the performance of the system over time. The primary objective and outputs were lists of the number of persons, positions, and skills required in 6 months intervals. These forecasts bounded the training and other personnel processes at various points in the future (Once formulated, the model could also be used to experiment with various personnel/management policies, such as, "always fill managerial positions from within", that affected the characteristics of the system).

Implementing of the forecasting model was the next place where computer technology was desirable, primarily because it was seen as a continuing process, i.e., one that would be used periodically for management experimentation or for forecast revisions as a function of plan changes, just as with the preceding analyses.

It is noted, for emphasis, that the criterion for training content determination was the output of the model, rather than currently performed work. This approach offered better face validity and, perhaps, true validity to the extent that plans and analysis of them and other trends tended to reflect the true changes in the work tasks to be done. The model provided quantitative information to aid in formulation and evaluation of behavioral objectives and evaluation of alternative training methods.

The remaining steps in the training development process followed the usual sequence in the systems approach. It is noteworthy, though, that as behavioral objectives were written correspondence was maintained with the task and skill data and with the position description data which also resulted from the analyses. The correspondence was both logically maintained as well as procedurally maintained through the coding schemes which were specified for incorporation into the personnel files and procedures and into the training files and procedures.

The only other observation about this process of significance was the potential impact of the improved precision both in personnel and training on the process of technical planning and managing. While this is clear by implication in Figure 1, analysis of effect could be determined only over a longer period than covered by the developmental stage discussed above.

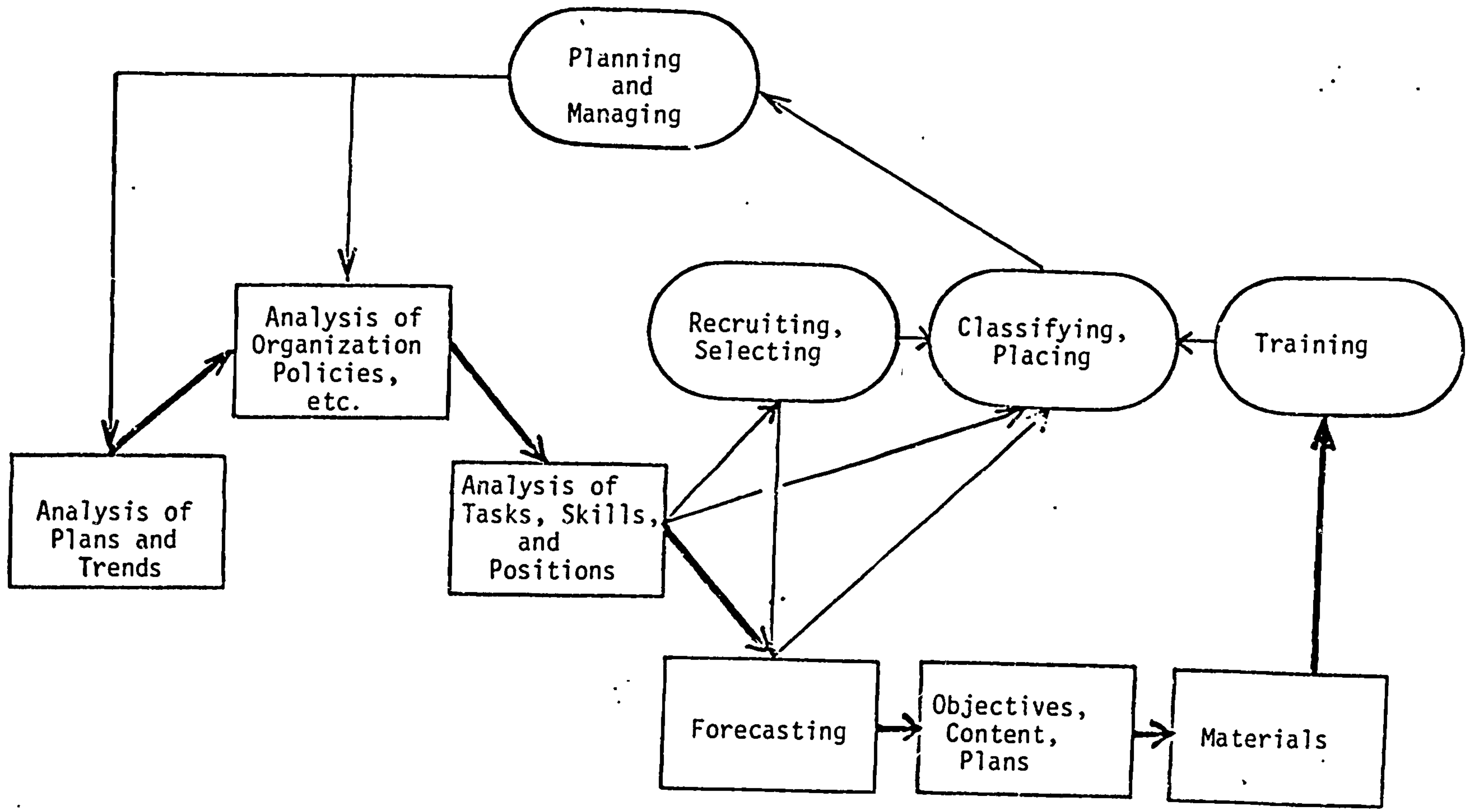

Figure 1. Training Development in Relation to Other Processes.

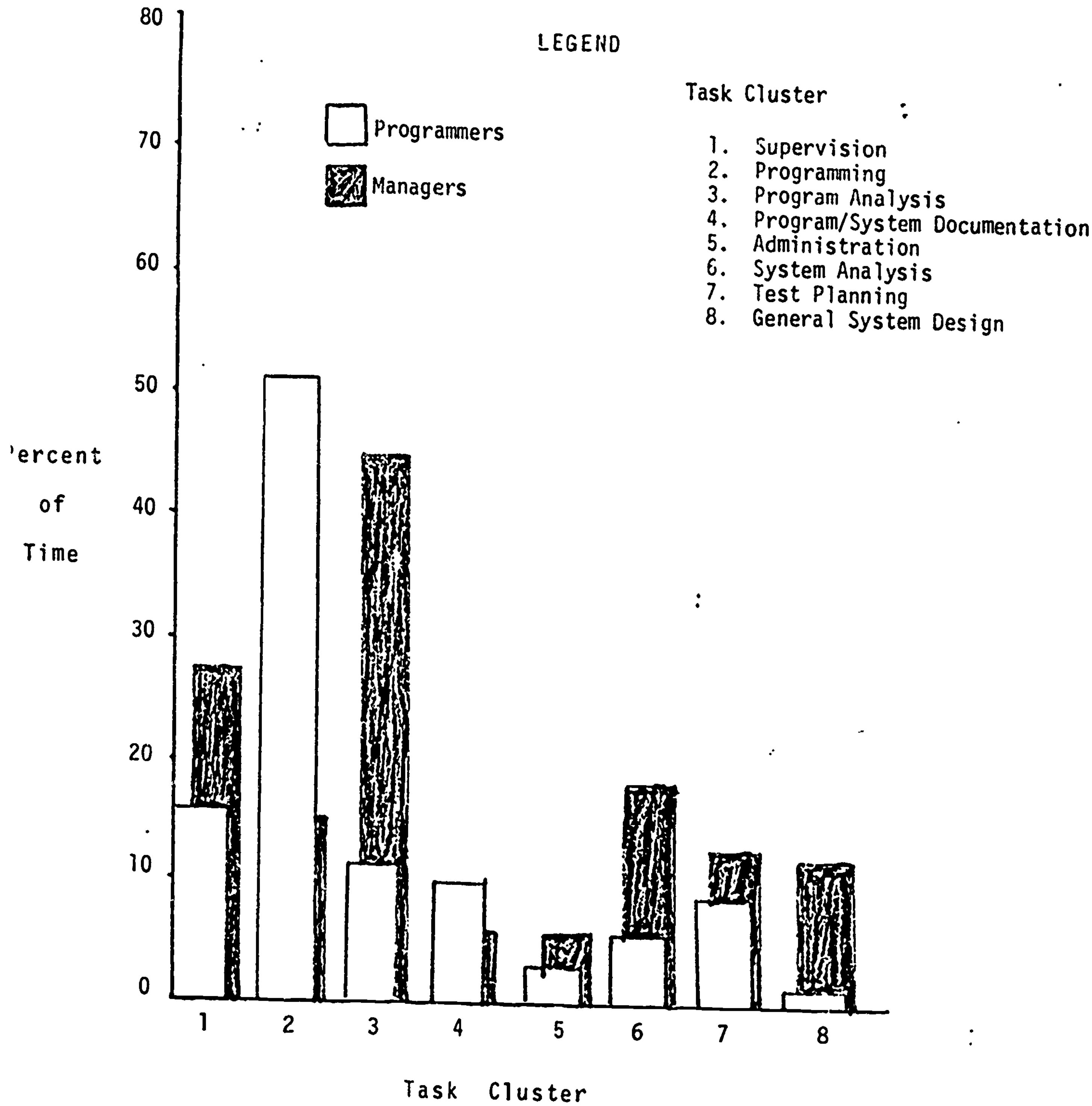

Figure 2. Comparison of Programmers and Managers on Task Clusters.

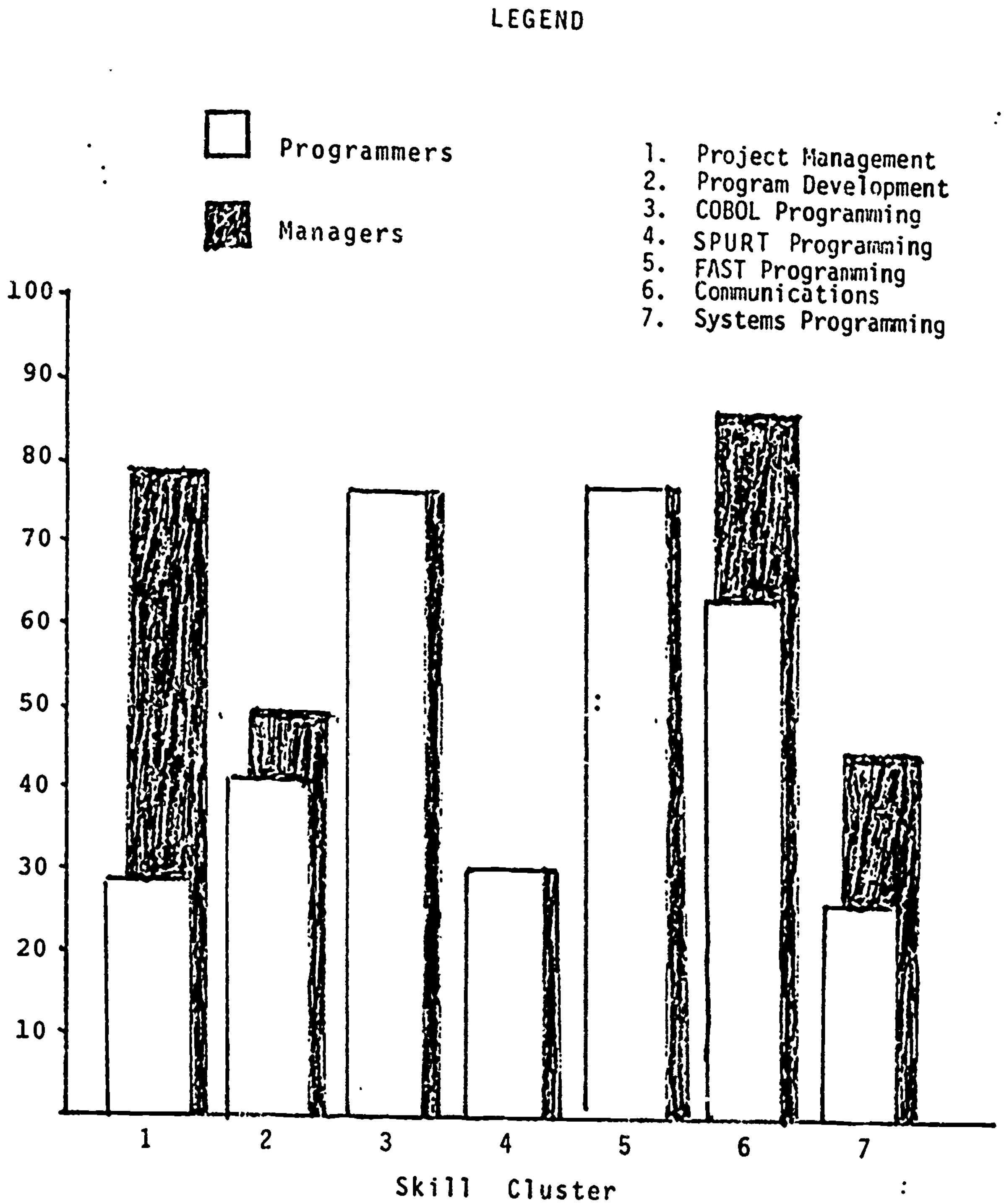

Figure 3. Comparison of Programmers and Managers on Skill Clusters.

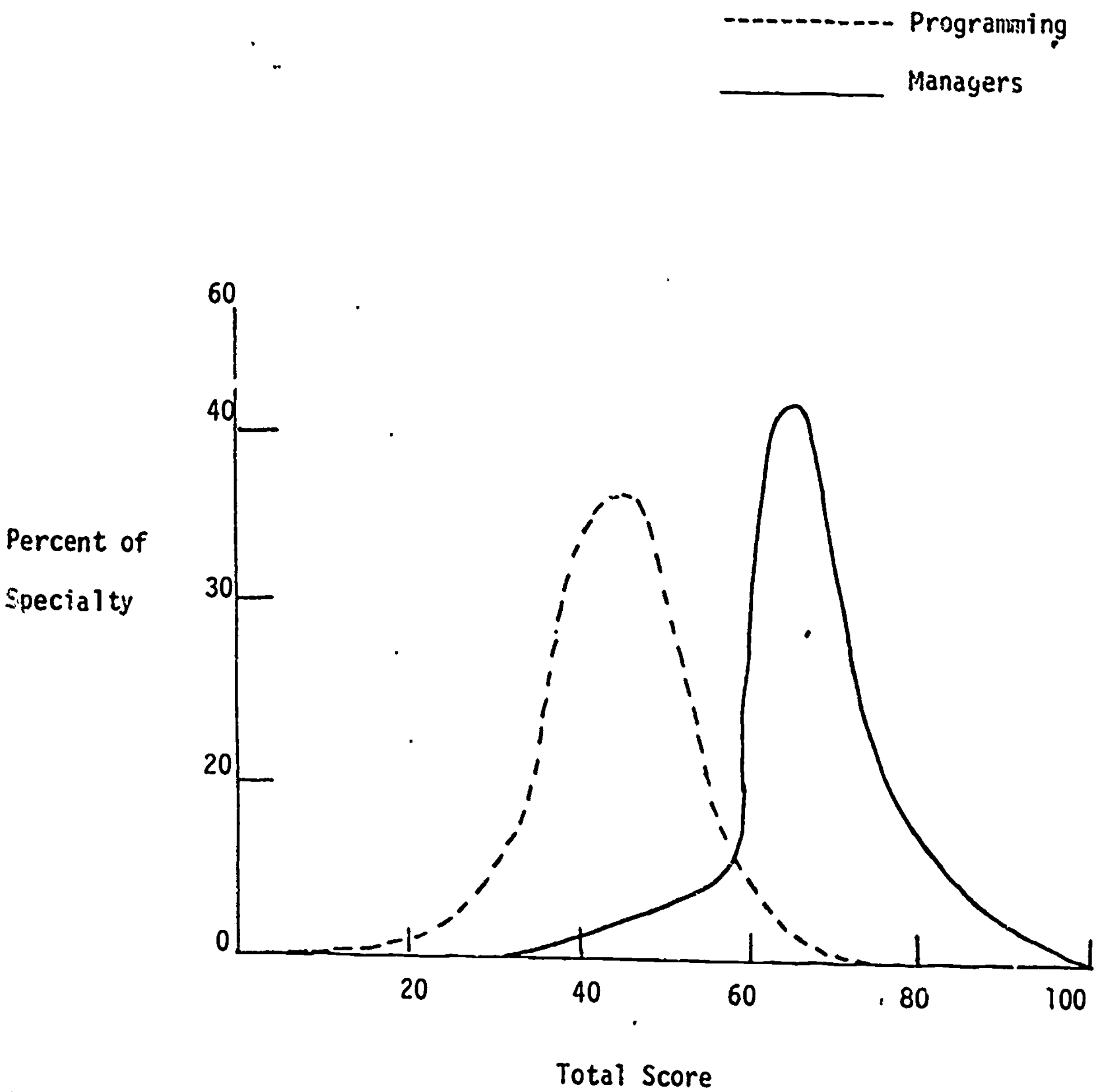

Figure 4. Comparison of the Distribution of Programming and Managers on Overall Index.